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**Protocol for Collecting Wildlife and
Fisheries Information through
FRDA Research**

by
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1 INTRODUCTION

1.1 The Need for Additional Information

The Canada-British Columbia Forest Resource Development Agreement (FRDA), 1985-1990, has committed \$300 million to backlog reforestation and intensive silviculture (FRDA Research Memo No. 005, October 1987). The amount of silvicultural activity implicit in that level of funding has the potential to profoundly affect the habitat of fish and wildlife over large areas.

The Extension, Demonstration, Research and Development Sub-Program of FRDA provides foresters with information on the wise and effective use of those funds. Regional technical committees develop and implement projects aimed at providing foresters with additional information on reforestation and silviculture. As of October 1987, the Northern Interior Technical Advisory Committee (NITAC) had initiated 34 such projects.

Most of NITAC's research and demonstration projects involve methods of encouraging conifer growth by inhibiting the growth of competing vegetation. Those methods include mechanical site preparation, prescribed fire, and herbicide application. However, biologists, trappers, and others have expressed concern about the impact of such silvicultural practices on wildlife and fish. The impacts, though potentially severe, are not well understood.

NITAC has responded to those concerns in two ways. It has developed projects that focus specifically on wildlife/fisheries issues: downslope movement of hexazinone; autecology of willow species; effects of glyphosate on willow species; and effects of glyphosate on small mammal populations. Because these projects address only a limited variety of silvicultural practices and impacts, the Committee has also proposed that existing projects be reviewed and modified (where practical) to provide additional data on the response of wildlife and fish to silvicultural treatments. This report is the result of that proposal.

Although silvicultural objectives are often in conflict with wildlife management objectives, the British Columbia Ministry of Forests is committed to planning the use of forest resources in a way that recognizes fisheries, wildlife, and other resource values (Ministry of Forests Act 1980, Section 4c). As well, FRDA is committed to developing "strategies to accommodate other resource values" (Five-Year Plan for Extension, Demonstration, Research and Development Sub-Program of FRDA 1985-1990).

Information on the response of wildlife and fish to silvicultural practices can be used by forest managers in a variety of ways. It can assist them with decisions about which treatments to apply on which sites, taking into account habitat values as well as timber values. It can be used to ensure that negative impacts on habitat values are no more severe or long-lasting than is necessary to achieve silvicultural objectives. It can be used in devising mitigation and enhancement practices to help compensate for areas where habitat values have been adversely affected by silvicultural treatments.

This report is oriented primarily towards wildlife rather than fisheries. The impacts of silvicultural activities on wildlife tend to be more direct and extensive than those on fisheries. Concerns over the latter may arise if there is encroachment into riparian areas, or if the silvicultural activities result in upslope erosion. However, most information needs regarding the effects of silvicultural activities on fisheries are better addressed through studies specifically designed to meet those objectives.

Much can be learned about the effects of silvicultural practices on wildlife by monitoring habitat characteristics and animal use. Nevertheless, readers should be aware of the limitations of wildlife-related measures that are added on to studies designed to measure silvicultural effects of treatments. Most wildlife-related measures require treatment areas and study plots that are larger than those ordinarily used in silviculture research. Study site selection, experimental design, and monitoring schedules are not the same for wildlife and silvicultural purposes (although monitoring for both requires a timeframe far longer than that imposed by the constraints of the FRDA program, which ends in March 1990).

The results of the research activities recommended in this report are more likely to highlight topics for further investigation than to provide definitive answers. At the present low level of understanding, however, even pilot data are valuable.

To ensure that the greatest possible benefits are derived from the additional work proposed in this report, it is essential that the wildlife- and fisheries-related results of the various projects be summarized and interpreted as soon as possible.

1.2 Objectives

The objectives of this project are:

1. To review existing NITAC projects for their potential to provide information about impacts on wildlife and fish and their habitat.
2. To recommend modifications to those projects which offer the greatest opportunities to integrate wildlife and fisheries concerns.
3. To prepare a protocol for measuring wildlife and fisheries response to silvicultural treatments, to be used in future NITAC projects.

1.3 Effects of Silvicultural Practices on Wildlife

1.3.1 Diversity of wildlife responses to habitat changes

The term "wildlife" in British Columbia refers to a large assemblage of different vertebrates whose behavioural and population responses to changes in forest cover may vary widely. For example, land management practices that retain or protect browsing opportunities for moose may or may not provide benefits to other wildlife species of local interest. Thus, "wildlife habitat" is functionally meaningless at the local level until some particular species (or group of species with similar requirements) is specified.

Environmental conditions important to wildlife vary from one forest successional stage to another (Figure 1). Different wildlife species and species groups respond differently to the various combinations of environmental attributes.

		Successional stages					
		Grass-forb	Shrub-seedling	Pole-sapling	Young	Mature	Old growth
Environmental variable	Plant diversity	..	.....	...	.	..	...
	Vegetation height		.	..	...	.....	.....
	Canopy volume		.	..	...	.....	.....
	Canopy closure	.	..	....	....	....	...
	Structural diversity	.	....	.	.	..	.....
	Forage production	.....	...	.	.	..	...
	Browse production	.	.....	.	.	..	...
	Animal diversity	...	....	.	..	.....	....

FIGURE 1. Forest successional stages and related environmental conditions (Thomas 1979, p. 26). Number of dots indicates the relative amount of each environmental variable at each successional stage.

The NITAC projects under review in this report all relate to reforestation. Therefore, the wildlife species of interest are those that are associated with, and that usually realize their best productivity and population growth in, areas dominated by early seral stages of forest succession. It is beyond the scope of this report to identify all such species, but some examples may help illustrate the point that even within that group, species requirements vary and no stage or component of forest regrowth can be singled out as the only one of concern for "wildlife":

- Microtine rodents of interest as prey for other species of value to society (some furbearers and raptors) may thrive in the first few years of regrowth, when herbaceous cover is a common or predominant feature (Stephenson 1984).
- Moose use of clearcuts in the Prince George area ranged from near zero just after cutting, to a peak somewhere between 10 and 25 years later, then declined to very low levels from 25 to 90 years (Eastman 1977).
- For beaver, aspen stands are thought to constitute the most significant habitat in British Columbia (Slough and Sadleir 1977). The optimum age of such stands for beaver use is in the range of 20 to 35 years (Gese and Shadle 1943; Bailey 1981).
- Snowshoe hares, the base prey for valuable furbearers such as lynx and fisher, appear to be best supported in mid-successional habitats, e.g., 15-50 years post-burn in interior Alaska (Stephenson 1984).

Other species such as mule and white-tailed deer, elk, black bears, Ruffed Grouse, and a variety of hole-nesting birds are also known to use or depend upon one or more components of a developing "aspen ecosystem" (Gullion 1977). Furthermore, for any one wildlife species, the extent and duration of favourable seral communities at a site doubtlessly depend upon a number of biogeoclimatic factors, and may be influenced by the activities of the animals themselves. The major points emerging from all this are that forest regrowth/wildlife relationships are not simple, and that many of the socially and economically important wildlife species are involved.

1.3.2 Reduced duration of early seral habitats

Historically, early seral habitats were produced by natural events, particularly wildfire. Active fire suppression by forestry interests over the last several decades has reduced the incidence of fire, and therefore the extent of those new habitats coming into production. Seral habitats in logged areas, though generally considered to produce fewer wildlife than seral habitats in most burns, can make up for some of that lost potential. Silvicultural objectives — which are directed to minimizing or eliminating the early, deciduous-dominated stages of forest growth — appear to be in fundamental conflict with wildlife management objectives in the sense that both cannot be realized on precisely the same plot of ground at the same time. Silvicultural language, which describes wildlife food and cover plants as "weeds" and "non-productive brush," highlights that conflict.

The major potential impact of silviculture on wildlife, regardless of method, is therefore reduction in extent and duration of productive habitats. This point is illustrated in Figure 2, which shows the potential effects of intensive forest management on wildlife species using particular seral stages in an area of western Oregon. Although a comparable analysis for northern British Columbia would differ in numbers of species using each stage, the general pattern would be similar. Thus, the impact of silvicultural activities on wildlife at any given site may be lowest when treatments are only partly successful, or when they are designed to leave a portion of the site untreated. Some patterns of treatment, probably those promoting a patchwork of developing communities and/or buffering at the edges, may actually enhance wildlife production.

1.3.3 Uncertainties related to chemical treatment

Additional concerns about chemical treatment are mostly associated with unknowns. Direct toxicity, resulting in death or obvious illness of animals, should be only a minor concern since it receives the most attention in laboratory testing. Exposed animals in apparent good health may nevertheless be subject, in either the short or long term, to subtle endocrine, genetic, or nutrient deficiency effects that manifest themselves in inconspicuous ways, such as diminished reproduction (Barrett 1988) or altered behaviour patterns that reduce ability to survive. Furthermore, wildlife food plants not killed by the treatment may nevertheless become less abundant or useful to animals because of changes in growth rate, productivity (seeds, berries), nutrient uptake, or hormone cycles, or because of treatment effects on other organisms such as pollinating insects. While some of these examples are obviously speculative, they serve to indicate the potential scope of the problem.

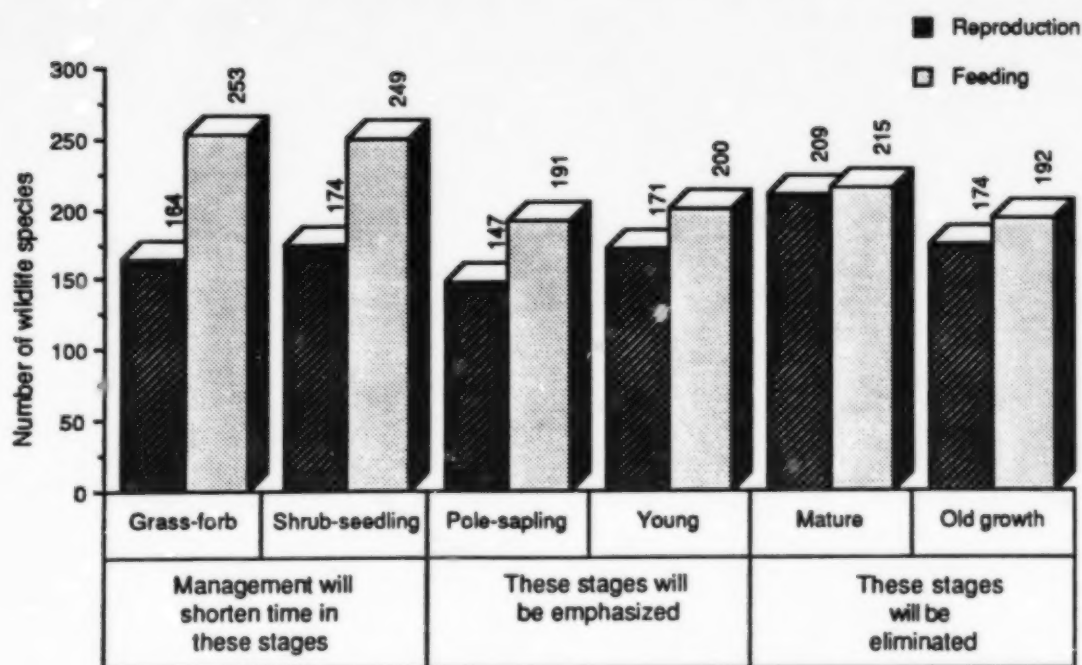


FIGURE 2. Number of wildlife species in the Blue Mountains, Oregon, oriented to forest successional stages and the potential effect of intensive timber management (Thomas 1979, p. 33).

It is clear that neither forest nor wildlife scientists can yet identify, let alone understand, all of the numerous interactions between micro- and macro-organisms and their environments at each site. As a result, we may not know enough to measure something that is important, or to miss it if it were gone. It is also clear that once a chemical has been approved for use, the only opportunity to discover an unpleasant and unexpected effect is in the field. Such discoveries are not unprecedented.

1.4 Effects of Silvicultural Practices on Fish

The implications of silvicultural activities for fish habitat tend to be minor compared to road building and forest harvesting practices. When silvicultural activities do influence fish, it is usually on a site-specific basis. Impacts may result from activities that are carried on in sensitive areas, such as on soils that are highly susceptible to erosion or in alluvial sites that may be used on a seasonal basis by fish.

Larger, well-known fish streams are usually recognized as being important, and therefore usually receive careful treatment during silvicultural activities. Nevertheless, small streams are often responsible for producing a high proportion of fish in a watershed, and for maintaining the quality of habitat in larger tributaries downstream. In some instances, small streams may provide critical habitat for some portion of fish life history, but may not be used at other times of the year. Small streams are also the ones most easily altered by silvicultural activities.

1.4.1 Modification of vegetation

The riparian zones of small streams are highly responsive to alterations in vegetative cover. Those streams typically have a closed canopy before treatment and are largely dependent on litterfall for organic energy input. Removal of the canopy results in direct solar heating, a shift from a detrital energy base to a solar base, and often increases in the quantity of woody debris in the channel. The very process of converting the streamside areas from brush cover to conifers may result in decreased fish production along those sections of stream. Typically, streams receiving energy inputs (leaves and twigs) from deciduous canopies are more productive for invertebrates than are streams receiving

energy inputs from coniferous canopies. Conversion to conifers ultimately results in less food available for fish using the streams.

1.4.2 Broadcast burning

Broadcast burning may affect fish habitat by causing erosion and sedimentation (Feller 1982), by releasing nutrients¹, by increasing water temperature through removal of streamside shade, and by resulting in direct heating. The most important effect of burning is erosion and increased sediment introduction into streams; other effects are minor in most cases. Everest and Harr (1982) indicate that increased surface erosion is most prevalent following broadcast burns, with mass erosion usually restricted to steep uplands. However, Brownlee *et al.* (1988) found no increase in sediment concentrations in study streams east of Prince George following slashburning or scarification of adjacent logged sites. The slashburn was light and avoided the immediate stream area. Bustard and Wilford (1986) noted that fire guards installed before burning can be a significant source of sediment if erosion control measures such as water bars are not part of their design.

1.4.3 Mechanical site preparation

The potential for erosion from broadcast burning or mechanical site preparation is directly related to the extent soil is exposed or disturbed, the slope gradient, the intensity of rainfall, the stability of the exposed soil, and the proximity of the site to water courses. Activities that impinge upon the riparian zone are more likely to affect the fish habitat than those undertaken away from the immediate stream environment. Damage to streambanks and channel morphology of small streams can occur if machinery is allowed to operate in the immediate vicinity of the stream channel. Alluvial floodplains along fish streams, as well as channels on seasonally flooded islands, are particularly sensitive areas that may not be recognized as important fish habitat. Sites that are high and dry, and that may be scarified during the dry season, may provide valuable refuge areas for fish during high flow periods.

1.4.4 Increased water temperature

Although increased sediment inputs to streams tend to damage fish habitat, changes leading to increased summer temperatures and increased nutrient levels following silvicultural activities must be evaluated on a site-specific basis. For example, while increased water temperature in small streams with already high temperatures may be damaging, some streams may benefit from increased water temperatures. After a broadcast burn that killed the streamside vegetation and consumed most of the slash, water temperatures rose 7-8 C into the lethal range for fish (Levno and Rothacher [1969]). On the other hand, Slaney *et al.* (1977) found that fish grew significantly larger where streamside vegetation was removed in a cool study stream east of Prince George.

1.4.5 Herbicides

The two forest herbicides that account for most forestry use in the interior of British Columbia, glyphosate and hexazinone, are the subject of extensive testing to determine the optimum application rates and timing of application. Both of those herbicides tend to have a low direct impact on aquatic organisms (U.S. Department of Agriculture 1984; Bronstad and Friestad 1985; Norris *et al.* 1983). Recent testing by over-spraying glyphosate on a small tributary to Carnation Creek has confirmed the low direct impact on coho salmon (Holtby and Baille 1989). With correct handling and observance of a pesticide-free zone, use of those herbicides should not be of direct concern for fish. However, complications resulting in indirect effects on fish may result if herbicides are used in the immediate stream environment. For example, herbicide use in the streamside zone could result in a loss of shade, cover, and food production.

¹ Feller, M.C. and J.P. Kimmins. 1981. Effects of clearcutting and slashburning on streamwater chemistry and watershed nutrient loss in southwestern British Columbia. Univ. of B.C., Faculty of Forestry. Unpubl. report.

2 REVIEW OF CURRENT FRDA PROJECTS

NITAC provided us with working plans for ongoing FRDA research projects that include field treatments or are otherwise relevant to wildlife/fisheries issues. We abstracted the pertinent features of those projects, using the working plans and contacting researchers by telephone, when necessary. Our project summaries are on file with the B.C. Ministry of Forests, Research Section, Prince Rupert Forest Region. Table 1 summarizes the major factors we considered in developing recommendations for modifying projects.

Most of the research projects we reviewed have progressed beyond the planning stage. In most cases, the pretreatment assessments and treatments have already taken place, and in some cases one or more post-treatment assessments are complete. Projects that are still in their early stages offer better opportunities for modification than projects that are well under way.

The small size of the treatment areas in most of the projects limits opportunities to incorporate measurements that are relevant to wildlife and fisheries. If the treatment area is not large enough to function as a habitat unit, then measurements of wildlife use may be difficult to carry out, and will certainly be difficult to interpret. Treatments involving soil disturbance may have little impact when limited to small areas, but may result in major hydrological effects when carried out operationally over a large portion of a watershed. However, measuring the effects of treatments on the vegetation community, to draw inferences about habitat values, is appropriate on moderately small plots.

We rated the degree to which each project, without modification, provided information that would allow inferences about treatment impacts on wildlife and fisheries to be made (present interpretation potential). In general, projects were rated "moderate" if the vegetation assessments were adequate to allow some habitat interpretations. For example, projects using the vegetation assessment methods for the Level B protocol described by Herring and Pollack (1985), or the methods of Trowbridge *et al.* (1986), fell into that category. Projects rated "high" were those that had a specific wildlife or fisheries orientation. We felt that even projects that were rated high in present interpretation potential could offer opportunities for modification.

For each project, we provided a rating of modification potential and a recommended modification. Levels 1, 2, and 3 refer to the protocol described in Section 3. Level 1 is a rapid vegetation assessment which can be incorporated into an existing project with a minimum of time and effort; it is recommended for most experimental field projects that do not already include the collection of similar vegetation data. Level 2 is a more thorough assessment of the structure and composition of vegetation; it is recommended most often for those projects that are still in the pretreatment phase. Level 3 incorporates measures of wildlife use as well as of the vegetation; it is applicable only to projects having large treatment areas.

Finally, we estimated the cost of carrying out the recommended modifications.

Our specific recommendations for existing projects are given in Section 4.

3 PROTOCOL

We have formulated measurements that are relevant to wildlife and fisheries into a three-tiered protocol, for incorporation into FRDA projects. Fisheries-related assessments are limited to simple observations on soil disturbance, described under "Level 1." More detailed assessments for fisheries are very technical. They would require a different study design, and do not seem warranted in the present context.

Most of our wildlife-related recommendations focus on measurements of the vegetation for two reasons. First, it is possible to make inferences about the suitability of a site as habitat for many wildlife species from information about the structure and composition of vegetation. Second, satisfactory information about the structure and composition of vegetation may be obtained through moderate effort, using existing methods. In this section we describe two levels of vegetation measurement for FRDA projects. Level 1 is intended to introduce a bare minimum of vegetation assessment at very low cost. Level 2 is intended to provide a more thorough assessment of the vegetation.

TABLE 1. Factors affecting the potential of FRDA projects to be modified to accommodate fish and wildlife concerns

Project number	Topic	Pretreatment assessments completed?	Size of treatment blocks (ha)	Present Interpretation potential	Modification potential	Recommended modification	Cost (person-days/assessment)
1.2	SP; glyphosate and mechanical for NSR aspen sites	Y	0.25	M	L	none	N/A
1.3-01	SP; hexazinone for aspen control	Y	0.02	L	M	Level 1	<2
1.3-02	CR; 3 herbicides for reedgrass control	Y	0.02	L	M	Level 1	<2
1.3-04	CR; 3 herbicides for general brush control	N	0.02	L	M	Level 1	<2
1.3-05	SP and CR; hexazinone for aspen control	Y	0.02	L	M	Level 1	<2
1.3-06	CR; 3 herbicides for general brush control	N	0.02	L	M	Level 1	<2
1.5	SP; prescribed burning for brush-fields and selectively logged	P	operational	M	L	none	N/A
1.10	SP; various mechanical and non-mechanical methods	Y	0.09 and operational	M	L	none	N/A
1.13	SR; knock down and burn dense PI	Y	1.00	M	M	Level 3	80 (total)
1.16	Demonstration plots for stand establishment practices	N/A	various	N/A	M	see text	6 (total)
1.17	SP and CR; silvicultural systems for ESSF brushfields	Y	0.04	M	M	Level 1	<2
1.18	Methodology for determining free-growing status	Y	0.11	L	M	Level 1	<2
1.19	Autecology of moose browse species	N/A	N/A	H	L	none	N/A
1.20-1	SP; prescribed burning for selectively logged stands	Y	0.24	M	L	none	N/A
1.20-2	SP; fire and vegetation dynamics study	Y	0.24	M	L	none	N/A
1.20-3	SP; micrometeorological study of burns	Y	0.24	L	L	none	N/A
1.20-4	SP; nutrient dynamics study	Y	0.24	L	L	none	N/A
1.22	Extension strategy	N/A	N/A	N/A	N/A	see text	N/A
1.23-01	CR; 4 herbicides for general brush control	P (2 of 12 completed)	0.45 and 0.09	L	M	Level 2	3
1.25	SP; soil and climate monitoring on FRDA 1.10 installations	Y	0.09 and operational	L	L	none	N/A

TABLE 1. (Concluded)

Project number	Topic	Pretreatment assessments completed?	Size of treatment blocks (ha)	Present interpretation potential	Modification potential	Recommended modification	Cost (person-days/assessment)
1.27	SP; competitive effects of vegetative strata in aspen stand	N	0.36	L	H	Level 2	2.5
1.33-PAUL	SP; effects of glyphosate on willow	N	0.002	H	M	see text	N/A
1.33-PG	SP; effects of glyphosate on willow	N	0.02 and 0.036	H	M	see text	N/A
1.34	CR; impact of glyphosate on small mammal populations	Y	operational	H	H	Level 3	80 (total)

SP - site preparation; CR - conifer release; SR - site rehabilitation

Y - yes; N - no; P - partially

L - low; M - moderate; H - high

N/A - not applicable

However, even Level 2 vegetation assessments do not address all the concerns of wildlife biologists. Often biologists do not have enough information about the habitat relationships of wildlife species to make sound inferences about habitat suitability from vegetation measurements. Furthermore, silvicultural practices do not necessarily affect wildlife only by changing the structure and species composition of the vegetation. For example, silvicultural treatments that affect the concentration of nutrients in forage plants may affect the use of the plants by wildlife. As suggested in Section 1, other direct and indirect effects on wildlife are also a possibility.

For these reasons, we also recommend that some studies of silvicultural treatments should incorporate measures of wildlife presence and use (Level 3) as well as vegetation measures. However, because wildlife and wildlife use by nature are more difficult to detect and measure than is vegetation, there is a need to determine what species or species groups can be monitored reliably, and to develop and test suitable survey methods. Developing such a protocol could not be accomplished in the time available for this project. Instead, we present some preliminary ideas for the developing and testing of such a protocol.

The protocol that follows is generalized so that it can be applied to a variety of projects. In any particular case, special wildlife or fisheries concerns may warrant modifying the protocol. Regional habitat, wildlife, and fisheries biologists in the Ministry of Environment should be consulted about specific projects.

3.1 Level 1

Level 1 represents a minimum standard of vegetation assessment, which will permit identification of only gross changes in the vegetation. It is recommended for projects that do not warrant more intensive data collection -- because the project is well under way, because treatment plots are so small that the effects of the treatment on the vegetation community cannot be assessed, or because the project has limited relevance to wildlife.

Level 1 assessments will be carried out on the same plots that are used for other project measurements. Thus, no extra time will be required for plot layout.

In each plot, the following assessments will be recorded:

1. Percent cover of the following vegetation layers:

- Dominant tree canopy (A1)
- Main tree canopy (A2)
- Secondary tree canopy (A3)
- Tall shrub layer (B1)
- Low shrub layer (B2)
- Herb layer (C)
- Moss layer (D)

See B.C. Ministry of Environment and Ministry of Forests² or B.C. Ministry of Environment and Parks³ for complete definitions of the layers. In most FRDA projects, no tree canopy will be present after treatment, and only four layer estimates will be required.

2. Percent cover of one to five selected species (e.g., *Calamagrostis canadensis*), genera (e.g., *Calamagrostis* spp.), or species groups (e.g., grasses) in each layer. The species that are selected will usually be the dominants, but may also be key forage species. The level to which the plants are identified will depend on the nature of the vegetation and the expertise of the field staff. The same species must be used each time the plot is reassessed.

3. A) Rate the degree of soil disturbance on the site:

Undisturbed

² B.C. Ministry of Environment and Ministry of Forests. 1988. Procedures for environmental monitoring in range and wildlife habitat management. Victoria, B.C. Draft report.

³ B.C. Ministry of Environment and Parks. 1988. Describing ecosystems in the field. In co-operation with B.C. Min. For. Lands, Victoria, B.C. Draft report.

Slightly disturbed
Deeply disturbed
Compacted

B) Describe evidence for any of the following:

Active erosion on site
Active erosion in area surrounding site
Overland flow of water on site

To maximize the precision of the vegetation estimates, field staff should use a guide to estimates of percent cover, such as the one reproduced in B.C. Ministry of Environment and Ministry of Forests⁴ (Figure 12).

Level 1 estimates are expected to require about 5 minutes per plot to complete. They can be carried out by project personnel with no special expertise in vegetation or soil assessment.

3.2 Level 2

Level 2 assessments are intended to provide detailed information about the structure and species composition of vegetation. They should be used routinely for new experimental projects in which treatment effects on wildlife habitat are a concern. They are inappropriate, however, if treatment areas are small (see below). If wildlife implications are potentially important, researchers should consider using treatment areas large enough that the Level 2 assessments can be made.

The Level 2 protocol is based on methods developed over several years by a multidisciplinary team in the B.C. Ministry of Environment and Ministry of Forests (1988)⁵. Those procedures are intended specifically for monitoring, over time, changes in habitat characteristics that result from management activities. Use of those standardized procedures will facilitate interpretation of results and comparison with other studies.

Procedures for applying the new provincial monitoring guidelines to the FRDA projects under NITAC are described below. The guidelines themselves should be consulted for specific information about the procedures. As well, Level 2 assessments should include the brief description of soil disturbance described above (Level 1, No. 3).

3.2.1 Site selection and sampling

Vegetation sampling is carried out within a landscape unit within a treatment area. Landscape units are areas that are homogeneous in topography, land form, present vegetation, and soils. The monitoring guidelines describe two sampling techniques: reconnaissance and multiplot sampling. Reconnaissance sampling is used to describe the average environmental and vegetative conditions on a single occasion. Multiplot sampling is used for repeated site and vegetation measurements to determine the effects of a management technique over time. It is the technique that will normally be required for FRDA projects.

In multiplot sampling, four circular macroplots are laid out along a transect within a landscape unit in the treatment area. Macroplots must be large enough to adequately describe the natural variation within the plant community. Suggested macroplot sizes are 380 m² (11-m radius) for forestlands and 201 m² (8-m radius) for shrublands. Instructions for laying out permanent macroplots are given in the monitoring guidelines. If a different plot layout is planned for other aspects of a FRDA study, that layout may also be used for collecting vegetation data, provided the above size and landscape unit requirements are met. In addition, the plots must be located far enough from the boundary of a treatment unit or landscape unit that the vegetation is not affected by the edge.

⁴ B.C. Ministry of Environment and Ministry of Forests, 1988.

⁵ Ibid.

3.2.2 Data collection

The monitoring guidelines include a variety of data sheets that are used in different combinations for different types of projects. The data sheets that are most applicable to habitat monitoring for the FRDA projects under NITAC are described below. The time estimates provided were determined in consultation with A. Harcombe, (B.C. Min. Environ.), and assume that the forms are being completed by a person who is familiar with the methodology. Actual time requirements may vary widely, depending on site characteristics and the experience of the field staff.

1. Project Description Form (EM-1)

This form is completed once for each project. It provides a permanent record of the project location and the management activity. Completion of the form is expected to require about 15 minutes.

2. Site Description Form (EM-2)

This form describes the ecological site characteristics and layout for each set of four macroplots. The section on sampling technique includes both information that is collected in the field and information that is transferred from maps in the office. It can be completed in about 30 minutes.

The section on plot layout is completed as the four macroplots are laid out on the ground. Plot layout is expected to take about 1 hour, under average field conditions. If a different plot layout is used, it must be described fully so that the plots can be relocated for future assessments.

The section on herbaceous forage production is optional for Level 2 assessments.

3. Vegetation Description Form (EM-3)

One vegetation form is completed for each macroplot. The vegetation form includes estimates of percent cover of all vegetation by strata, as given in the Level 1 protocol. It also includes a complete list of plant species growing in the sample plot. Percent cover, distribution class, and vigour, as defined in the monitoring guidelines, are recorded for each species. In the case of a vegetation description carried out immediately before a herbicide treatment, phenology should also be recorded. On average, the vegetation assessment is expected to require about 45 minutes for the first macroplot and 30 minutes for each subsequent macroplot. Additional office time may be required for species that cannot be identified in the field.

4. Prescribed Fire Form (EM-4)

Effects of prescribed burns on vegetation cannot be interpreted with confidence without information on the fire itself. Normally, FRDA projects will include detailed data collection on prescribed fires. The methodology presented by Trowbridge *et al.* (1986) is specifically oriented to slash burning, and requires about 4 person-days to carry out for each fire, including pre-burn assessments (2 person-days), burn observations (1 person-day), and an immediate post-burn assessment (1 person-day) (J. Parminter, B.C. Min. For., pers. comm.).

Alternatively, Form EM-4 may be used. This form is intended for use in habitat enhancement projects, and lacks data collection on slash characteristics. This methodology is expected to require only about 2 person-days, including pre-burn assessments (partial day), burn observations (1 person-day), and post-burn assessments (partial day) (J. Parminter, B.C. Min. For., pers. comm.).

5. Herbicide/Fertilizer Form (EM-5)

This form should be used for FRDA projects that involve herbicide or fertilizer application. It includes a record of the herbicide or fertilizer used, details of the application, environmental conditions before, during, and after application, and procedures for evaluating the impact of the treatment on tagged plants. In many FRDA projects, much of this information is likely to be recorded on other data sheets. Use of the tagged plant

evaluation is strongly recommended, and should include assessments of key forage species.

The EM-5 Form is expected to require less than 30 minutes to complete. Additional field time will be required if tagged plant evaluations are performed.

3.3 Level 3

Level 3 assessments respond to the need for a protocol that measures, more directly, the effects of silvicultural treatments on wildlife and wildlife use. For several reasons, we are unable to present a methodology for immediate use in FRDA projects:

- British Columbia biologists have not yet developed a complete methodology for measuring changes in wildlife and wildlife use over time. The Wildlife Data Forms developed by the B.C. Ministry of Environment and Parks⁶ are intended to characterize a habitat on a single occasion, not to detect changes over time. The forms are set up to be applicable to a variety of wildlife surveys in a variety of habitat types. Survey design is not specified. Development of a Level 3 protocol would require additional literature review, the participation of a statistician, and field testing.
- There is uncertainty among wildlife biologists about what wildlife species and species groups can be monitored at a survey level. For example, some small mammal species can be sampled reliably with snap traps, but others cannot (T. Sullivan, Applied Mammal Res. Inst., pers. comm.). Literature review and field testing will be required to determine which wildlife species are appropriate for inclusion in monitoring surveys.
- Field staff are likely to have less expertise in detecting and interpreting wildlife sign than in describing vegetation. Differences among observers could confound results. This problem might be addressed by the combination of careful documentation describing use of data sheets, and a brief training program for potential observers.
- The presence or absence of animals and sign in a particular study block might be related more to the characteristics of adjacent habitats, serving as dispersal centres, than to treatment effects on the study block. Therefore, it might be necessary to incorporate assessments of adjacent habitats into the survey design.

We believe a Level 3 protocol extends beyond the needs of NITAC, and should incorporate input from a broad base of potential users. Development of wildlife monitoring procedures similar to the new environmental monitoring procedures (B.C. Ministry of Environment and Ministry of Forest⁷) is being considered (D. Blower, B.C. Min. Environ., pers. comm.). We recommend that FRDA contribute to the development process by testing the suitability of the Wildlife Data Sheets as monitoring tools in one or more field projects. Our recommendations for incorporating wildlife monitoring into FRDA projects 1.13 and 1.34 are presented in Section 4. Some general considerations for developing a Level 3 protocol are given in Appendix 1.

4 RECOMMENDATIONS

4.1 Project-level Recommendations

In this section, we discuss those projects for which we have recommended modifications other than the addition of Level 1 assessments. Projects proposed for the Level 1 protocol are not discussed individually because the assessments are simple and quick to perform.

⁶ B.C. Ministry of Environment and Parks, 1988.

⁷ B.C. Ministry of Environment and Ministry of Forests, 1988.

FRDA Project 1.13

This project includes an intensive study of the effects of various burning prescriptions on subsequent vegetation dynamics and nutrient distribution. Because of the detailed vegetation information already included in the project and the relatively large size of the treatment areas (1 ha), it is a good candidate for a Level 3 study. Such an addition to FRDA 1.13 might best be handled as a separate contract to a wildlife biologist. The objectives of the proposed study are:

1. To identify relationships between post-fire vegetation structure and nutrient distribution, and wildlife abundance and habitat use; and
2. To contribute to the development of a Level 3 protocol by testing the suitability of existing government data sheets for wildlife monitoring, and by developing and testing a survey design.

To meet the second objective, the contractor would be expected to use the data sheets in B.C. Ministry of Environment and Parks⁸ for browse assessment and wildlife description. Preparing a suitable survey design would be the responsibility of the contractor.

We estimate that the project would require approximately 80 days over a 2-year period:

Reconnaissance and project planning	8 days
Data collection (16 days per year in four field trips, selected seasonally)	32 days
Data analysis	20 days
Report preparation	20 days

FRDA Project 1.16

Interpretations of treatment impacts on wildlife and fisheries values should be part of the extension program for the demonstration plots. We recommend that the plots be visited by a habitat biologist, who would provide interpretative material for use in the tour guides. Viewing the plots (except the one or two that are distant from Prince George) would require approximately 3 days (R. McMinn, pers. comm.). As well, 2 or 3 days should be allowed for preparation and interpretation.

FRDA Project 1.22

One of the objectives of this project was to identify the information needs of the personnel who implement the FRDA program⁹. Government, industry and consulting forestry staff were interviewed during the preliminary stages of this project. Interviewees were asked to identify, from a list of silviculture topics, those they needed more information on. Although integrated resource management was not included on the list, nor identified as an "information needs" topic, some interviewees expressed concern that people did not recognize the importance of integrated resource management until it became an issue. The authors of the report expressed their opinion that integrated resource management should be included as a topic in an extension program. They recommended that NITAC decide whether or not to make integrated resource management part of the FRDA extension program.

We concur with the authors of FRDA 1.22 that integrated resource management should be part of FRDA's extension program. That need is discussed further in the section on program-level recommendations.

FRDA Project 1.23-01

This project offers the opportunity to initiate detailed monitoring of the effects of several herbicides on vegetation composition and structure. Because the project has a demonstration component, it could be used to increase awareness of the effects of the herbicides on wildlife habitat.

⁸ B.C. Ministry of Environment and Parks, 1988.

⁹ Bunnell, P., and Pearce, C. 1988. Implementation of a FRDA extension strategy in NITAC. B.C. Ministry of Forests and Lands. Unpubl. report.

The following recommendations apply to the six 0.45-ha plots that have not yet been treated, and to the control. Four macroplots in each treatment area are required for vegetation assessments. It may be possible to save time by expanding four of the permanent 5-m² sample plots in each treatment area to an 8-m radius, taking into consideration distance from edges and from one another. If that is not feasible, then a systematic plot layout similar to that described in the monitoring guidelines may be used, with distances among plots reduced so they will fit within the treatment areas. The Project Description Form, Ecological Site Description Forms, and Vegetation Description Forms should be completed. The Herbicide/Fertilizer Form should also be completed if that information has not been recorded elsewhere. Tagged plant evaluations are already planned for the project.

Addition of the Level 2 assessments is expected to require 2.5-3.0 days each time the monitoring is done.

FRDA Project 1.27

This project is an excellent candidate for Level 2 assessments. It is located in a vegetation type that is particularly important to wildlife (Section 1), and it addresses the effects of manipulating various vegetation strata. However, the effects of those manipulations on wildlife cannot be inferred unless more data on species composition are collected. Treatment areas are large enough to allow the collection of Level 2 data, and the project is still at an early stage.

We recommend that Level 2 assessments be carried out in each of the five 0.36-ha treatment plots. Instead of the plot layout described in the monitoring guidelines being used, we suggest that each quadrant of the 40 x 40 m grid be treated as a macroplot. The Project Description Form, Ecological Site Description Forms, and Vegetation Description Forms should be completed. As well, the Herbicide/Fertilizer Form should be completed if that information has not been recorded elsewhere. Tagging plants is unnecessary in this project because condition codes of major vegetation species are being recorded in 25 small plots in each treatment area.

Addition of the Level 2 assessments is expected to require 2.0-2.5 days each time the monitoring is done.

FRDA Project 1.33

We have no recommendations for improving wildlife interpretations, but do have some general comments on the projects.

Both components of FRDA 1.33 are aimed at determining the effects of rate and timing of glyphosate application on willow species. That information may allow the development of prescriptions to achieve "adequate weed control in plantations, without grave damage to the genus." However, the planned assessments include only measures of the treatment effects on willows, not on other plants that are potential target species. Including measures of herbicide effects on other species would make it easier to identify the treatment variables that minimize damage to willows, yet control other competing vegetation.

If heavy browsing occurs on the experimental plots, results may be difficult to interpret because of interactions between degree of browsing and glyphosate effects. The original working plans for FRDA 1.33 did not address this potential problem. However, the field methods for the Prince George component of the project have since been modified to include data collection on browsing, so that browse-related effects can be separated from herbicide effects (B. Bancroft, Madrone Consultants Ltd., pers. comm.)

We note that a new methodology for assessing the impact of herbicides on selected browse species is under development^{10,11}. That methodology allows more detailed analysis of the effects of herbicides on within-plant architecture and growth patterns than does the methodology planned for

¹⁰ B.C. Ministry of Environment. 1988. User's guide to monitoring the impacts of herbicides on wildlife browse species. Victoria, B.C. Unpubl. report.

¹¹ Lloyd, R. 1988. Assessing the impact of glyphosate and liquid hexazone on moose browse species: second year report. Prepared for B.C. Fish and Wildlife Branch. Unpubl. report.

FRDA 1.33. Use of the new methodology should be considered if FRDA supports future projects on effects of herbicides on browse species.

FRDA Project 1.34

The purpose of this project is to determine the impact of glyphosate use on small mammal populations. Because its large treatment areas, detailed pretreatment vegetation assessments, and existing wildlife orientation, it is an excellent project for obtaining additional wildlife information and for testing monitoring methods.

We recommend that the work be contracted to a wildlife biologist, and that it have the following objectives:

1. To identify the impacts of glyphosate on the widest possible range of wildlife species; and
2. To contribute to the development of a Level 3 protocol by testing the suitability of existing government data sheets for wildlife monitoring, and by developing and testing a survey design.

To meet Objective 2, the contractor would be expected to use the data sheets in B.C. Ministry of Environment and Parks¹² for browse assessment and wildlife description. Preparing a suitable survey design would be the responsibility of the contractor.

The detailed data on small mammal populations provided by FRDA project 1.34 will serve as an excellent baseline for correlating indices of local use by other wildlife (Appendix 1), particularly some of the small carnivore furbearers. Those data will also provide a basis for developing and evaluating routine monitoring procedures for trends in numbers and species composition of small mammal populations (e.g., the saturation snap-trapping method proposed by Linn [1963]). The study should be carried out in co-ordination with the principal investigator for FRDA 1.34.

Our time estimate for the project is 80 days over 2 years, allocated as follows:

Reconnaissance and project planning	8 days
Data collection	32 days
spring/early summer	- 5 days
late summer/fall	- 5 days
early winter	- 3 days
late winter	- 3 days
Data analysis	20 days
Report preparation	20 days

4.2 Program-level Recommendations

Consistent with the mandates of the Ministry of Forests and FRDA, NITAC is making a considerable investment in identifying the impacts of silvicultural treatments on wildlife and fisheries values. To realize that investment, NITAC must ensure that the results of wildlife- and fisheries-related research are summarized, interpreted, and communicated to those who carry out silviculture. We make two specific recommendations regarding how that might be done:

1. NITAC should assign integrated resource management a high priority within the FRDA extension program.
2. In the final year of FRDA, a biologist should review all the wildlife- and fisheries-related results of the NITAC research projects, summarize and interpret them, and make recommendations for continued monitoring.

12 B.C. Ministry of Environment and Parks, 1988.

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APPENDIX 1. A preliminary list of components and considerations for documenting wildlife occurrence and habitat use in silviculture research areas in British Columbia

Introduction

In the text of this report, two levels of vegetation sampling have been described and recommended for monitoring the effects of silvicultural treatments on wildlife habitat. A third level, directed to documenting the actual nature and extent of wildlife use of treatment and control habitats, would also be desirable. However, developing a complete "Level 3 Protocol" is not possible within the time and budget constraints of the present project. Some operational problems and potential solutions were discussed briefly in the text. Several potential components of Level 3 studies are outlined below.

General Procedure

Sampling would be done by having someone walk along designated transect lines and record all direct contacts with wildlife (animals seen or heard) and all occurrences of wildlife "sign," as described below. Some consideration and/or provision for "effective strip width" (the distance from the transect line that certain observations can be made in the vegetation cover) is required so that comparisons can be made. As noted in text, there is also a need to consider what level and intensity of sampling are required for statistical analyses.

Timing

The occurrence and/or detectability of wildlife in certain study plots may be seasonal; thus, sampling may be required at several times of the year for general wildlife assessments, or only at certain times for studies emphasizing particular wildlife species or species groups.

Data Characteristics

A) Direct contact

For most mammals, reptiles, and amphibians, and for birds during most of the year, field contacts are likely to be incidental and sporadic. Primarily, they would provide information for local species lists, but contribute little to the understanding of individual species abundance, distribution, and habitat use. A potential exception is the "breeding bird survey" (see Erskine 1977), which detects and quantifies bird occurrence by territorial vocalizations in the spring (including night surveys for owls). Variations in the scale of such surveys may be possible. Some species, particularly small mammals, may be best assessed by some form of systematic trapping procedure along field transect lines. Some literature review and consultation with experts would be required to work out the details of both bird and small mammal survey systems.

B) Sign

Various kinds of sign are the most consistent - and therefore best - representation of occurrence for many animal species, since they do not require that the animals be present or that direct contact be made when the survey is done. Some sign is more conspicuous or easily recognized than others, and some can be sampled only in particular seasons. In addition, some kinds of sign are amenable to detailed quantitative surveys and measurements at the ordinal level (high-medium-low; large-medium-small; scale of 1-x). Some examples of field sign that might be recorded in a developed Level 3 program are as follows:

Feces

Pellets and scats have commonly been used in quantifying wildlife occurrence and sometimes abundance (e.g., see Stordeur 1984 and Krebs *et al.* 1987). Some fecal remains can be easily assigned to particular wildlife species and even to season of deposition. Others may be distinguishable to genus (e.g., bears) or order (e.g., some small carnivores), but not to species without additional sign. Feces may also be distinguished as "fresh" or "old" by features such as

extent of drying. For ungulates, distinctions can be made between winter (pellet-form) and the more amorphous summer droppings; for bears, scats may be distinguished as "spring" (containing mostly green vegetation) or "fall" (mostly berries).

Feeding sites

The most commonly obtained data of this type are incidence and extent of browsing by ungulates, measured either by detailed quantitative means or by qualitative assessments such as nil, light (a few twigs per plant), moderate (many twigs), or heavy (shrub growth form greatly altered). Other sign of feeding includes barking by various animals, from voles and porcupines to moose; clipping and girdling by hares; cone-cutting and midden accumulations by squirrels, and prey remains from carnivores. Compilations such as that by Harestad *et al.* (1986) for animal damage would be a useful reference for identification of feeding sign.

Tracks

During the snowfree season, observations of tracks are usually incidental, depending on availability of suitable substrate such as muddy stream banks. Thus, the information obtained is similar to that for direct contacts: enabling only identification of species presence. However, there have been some successes with using strategically placed natural or artificial tracking substrates to measure animal abundance and activity in spring through summer (Sarrazin and Bider 1973; Barrett¹, and others). The best procedure for monitoring furbearer occurrence in study plots is probably winter track counts in snow (e.g., see Slough and Jessup 1984). Information on other species, including ungulates, grouse, and some small mammals, could also be obtained incidentally by a winter tracking program.

Trails

Game trails may be distinguished as heavily used (worn to soil), moderately used (well defined on litter or through ground vegetation), or occasionally used (faint); and may be clearly associated with species (moose, bear, beaver, hare, squirrel) or only to species groups (e.g., big game).

Other

Other kinds of sign that may regularly occur include structures such as mammal burrows, dens, runways, grouse dust-baths, and bird nests or nesting cavities. Other incidental sign that might be recorded include skeletal or other remains of dead animals and seasonally shed structures such as hair, feathers, and antlers.

Data comparisons

Transect results would be expressed as observations per unit, thus enabling comparisons of the form: 15 bear scats/km in treated sites versus 7 scats/km in control sites, or 4 marten tracks/km in control sites versus 0.2 tracks/km in treatment areas.

¹ Barrett, R.H. 1982. Smoked aluminum track plots for determining furbearer distribution and relative abundance. Unpubl. manuscript submitted to Cal. Fish Game.

APPENDIX 2 Personnel contacted

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MOE - Ministry of Environment	
MOF - Ministry of Forests	